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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Hideyoshi HORIMAI

Group Art Unit: 2872

Application No.: 09/601,702

Examiner: A. Lavarias

Filed: August 4, 2000

Docket No.: 106357

For: APPARATUS AND METHOD FOR RECORDING AND REPRODUCING OPTICAL  
INFORMATION (AS AMENDED)

AMENDMENT UNDER 37 C.F.R. §1.111

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In reply to the May 13, 2004 Office Action, please consider the following:

**Amendments to the Claims** as reflected in the listing of claims; and

**Remarks.**

**Amendments to the Claims:**

The following listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) An optical information recording~~and reproducing~~ apparatus for recording information in ~~and reproducing information from an~~ optical information recording medium having a reflecting ~~film layer~~ and an information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying the information and reference light for recording having a ~~spatially modulated phase~~spatial modulation, the apparatus comprising:

information light generation means for generating information light carrying information;

recording reference light generation means including ~~phase-modulation means~~ for spatially modulating the ~~phase of~~ light, for generating reference light for recording ~~having a being~~phase-spatially modulated by the ~~phase-modulation means; and~~

a recording optical system including only one object lens for projecting the information light generated by the information light generation means and the reference light for recording generated by the recording reference light generation means upon the optical information recording medium, for illuminating the information recording layer on the same side thereof with the information light ~~generated by the information light generation means~~ and the reference light for recording ~~generated by the recording reference light generation means~~ such that the information is recorded in the information recording layer in the form of an interference pattern as a result of interference between the information light and the reference light for recording;

wherein the recording optical system projects the information light and the reference light for recording such that an optical axis of the information light and an optical axis of the reference light for recording are located on a same line.

~~reproduction reference light generation means including phase modulation means for spatially modulating the phase of light in the same manner in which the reference light was modulated when the information was recorded, for generating reference light for reproduction having a phase spatially modulated by the phase modulation means;~~

~~a reproducing optical system for illuminating the information recording layer with the reference light for reproduction generated by the reproduction reference light generation means on the same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction; and~~

~~detection means for detecting the reproduction light collected by the reproducing optical system.~~

2. (Previously Presented) The optical information recording apparatus according to claim 1, wherein the optical information recording medium has a positioning region for recording information for positioning the information light and the reference light for recording, the apparatus further comprising position control means for controlling the positions of the information light and the reference light for recording relative to the optical information recording medium using the information recorded in the positioning region.

3.-5. (Cancelled)

6. (Currently Amended) An optical information recording ~~and reproducing~~ method for recording information in ~~and reproducing information from~~ an optical information

recording medium having a reflecting ~~film layer~~ and an information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying the information and reference light for recording having a ~~spatially modulated phase~~spatial modulation, the method comprising the steps of:

generating information light carrying information;

spatially modulating the ~~phase of light~~ to generate reference light for recording having a ~~spatially modulated phase~~spatial modulation; and

illuminating the information recording layer on the same side thereof with the information light and the reference light for recording through only one object lens such that an optical axis of the information light and an optical axis of the reference light for recording are located on a same line to record the information in the information recording layer in the form of an interference pattern as a result of interference between the information light and the reference light for recording;

~~spatially modulating the phase of light to generate reference light for reproduction having a spatially modulated phase modulated in the same manner in which the reference light was modulated when the information was recorded;~~

~~illuminating the information recording layer with the reference light for reproduction on the same side of the information recording layer that is illuminated with the information light and the reference light for recording and collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction; and~~

~~detecting the collected reproduction light.~~

7. (Currently Amended) An optical information reproducing apparatus for reproducing information utilizing holography from an optical information recording medium having a reflecting ~~film layer~~ and an information recording layer in which the information is recorded in the form of an interference pattern as a result of interference between information light carrying the information and reference light for recording having a ~~spatially modulated phasespatial modulation~~, the apparatus comprising:

reproduction reference light generation means including ~~phase-modulation~~ means for spatially modulating the ~~phase of light~~, for generating reference light for reproduction ~~having a phase being~~ spatially modulated by the ~~phase-modulation~~ means in the same manner in which the reference light was modulated when the information was recorded;

a reproducing optical system including only one object lens for projecting the reference light for reproduction generated by the reproduction reference light generation means upon the optical information recording medium and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction, for illuminating the information recording layer with the reference light for reproduction ~~generated by the reproduction reference light generation means on the a~~ same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting reproduction light ~~generated at the information recording layer when illuminated with the reference light for reproduction on the same side of~~ the information recording layer that is illuminated with the reference light for reproduction; and

detection means for detecting the reproduction light collected by the reproducing optical system;

wherein the reproducing optical system projects the reference light for reproduction and collects the reproduction light such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on a same line.

8. (Previously Presented) The optical information reproducing apparatus according to claim 7, wherein the optical information recording medium has a positioning region for recording information for positioning the reference light for reproduction, the apparatus further comprising position control means for controlling the position of the reference light for reproduction relative to the optical information recording medium using the information recorded in the positioning region.

9.-15. (Cancelled)

16. (Currently Amended) An optical information reproducing apparatus for reproducing information utilizing holography from an optical information recording medium having a reflecting ~~film~~ layer and an information recording layer in which the information is recorded in the form of an interference pattern as a result of interference between information light having a wavelength selected from among a plurality of wavelengths and carrying the information and reference light for recording having the wavelength selected from among a plurality of wavelengths, the apparatus comprising:

wavelength selection means for selecting a wavelength of light illuminating the information recording layer from among a plurality of wavelengths;

reproduction reference light generation means for generating reference light for reproduction having the wavelength selected by the wavelength selection means, said reproduction reference light generation means including modulation means for spatially modulating ~~the phase of~~ the reproduction reference light in the same manner in which the reference light was modulated when the information was recorded;

a reproducing optical system including only one object lens for projecting the reference light for reproduction generated by the reproduction reference light generation means upon the optical information recording medium and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction, for illuminating the information recording layer with the reference light for reproduction ~~generated by the reproduction reference light generation means~~ on the same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting reproduction light ~~generated at the information recording layer when illuminated with the reference light for reproduction~~ on the same side of the information recording layer that is illuminated with the reference light for reproduction; and

detection means for detecting the reproduction light collected by the reproducing optical system;-

wherein the reproducing optical system projects the reference light for reproduction and collects the reproduction light such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on a same line.

17. (Previously Presented) The optical information reproducing apparatus according to claim 16, wherein the optical information recording medium has a positioning region for recording information for positioning the reference light for reproduction, the apparatus further comprising position control means for controlling the position of the reference light for reproduction relative to the optical information recording medium using the information recorded in the positioning region.

18.-50. (Cancelled)

51. (Currently Amended) An optical information recording and reproducing apparatus for recording information in and reproducing information from an optical

information recording medium having a reflecting ~~layer~~film and an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

an information light generator that generates information light by first modulating a first light based on first information;

a recording reference light generator that modulates a second light to generate a reference light for recording based on second information;

a recording optical system including only one object lens for projecting the information and the reference light for recording upon the optical information recording medium, for illuminating the information recording layer with the information light and the reference light for recording, the information light and the reference light for recording illuminating the information recording layer on a same side such that the first and the second information ~~is~~ are recorded in the information recording layer as an interference pattern between the information light and the reference light for recording, wherein the recording optical system projects the information light and the reference light for recording such that a first optical axis of the information light and a second optical axis of the reference light for recording are located on a first same line;

~~reproduction reference light generation~~generator means that modulates a light to generate a reference light for reproduction based on the second information including phase modulation means for spatially modulating the phase of light, for generating reference light for reproduction having a phase spatially modulated by the phase modulation means in the same manner in which the reference light was modulated when the information was recorded;

a reproducing optical system including the object lens for projecting the reference light for reproduction upon the optical information recording medium and for collecting reproduction light generated at the information recording layer when illuminated



with the reference light for reproduction, for illuminating the information recording layer with the reference light for reproduction generated by the reproduction reference light generation means on the same side of the information recording layer that is illuminated with the information light and the reference light for recording and for collecting the reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction, wherein the reproducing optical system projects the reference light for reproduction and collects the reproduction light such that a third optical axis of the reference light for reproduction and a fourth optical axis of the reproduction light are located on a second same line; and

detection means for detecting the reproduction light collected by the reproducing optical system.

52. (Previously Presented) The optical information recording and reproducing apparatus according to claim 51, further comprising:

a position controller that positions the information light and the reference light on the optical information recording medium based on positioning information in the optical information recording medium.

53. (Previously Presented) The optical information recording and reproducing apparatus according to claim 51, wherein the recording reference light generator performs one or more of spatially modulating the second light and phase modulating the second light to generate the reference light.

54. (Currently Amended) An optical information recording and reproducing method for recording information in and reproducing information from an optical information recording medium having a reflecting layer film and an information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result

of interference between information light carrying the information and reference light for recording having a ~~spatially modulated phase~~spatial modulation, the method comprising:

generating information light carrying information;

generating reference light;

modulating the reference light;

illuminating the information recording layer with the information light and modulated reference light on a same side of the optical information recording medium through only one object lens such that an optical axis of the information light and an optical axis of the reference light for recording are located on a same line;

recording the information in the information recording layer as an interference pattern between the information light and the modulated reference light;

spatially modulating the ~~phase of light~~ to generate reference light for reproduction having a ~~spatially modulated phase~~spatial modulation in the same manner in which the reference light was modulated when the information was recorded;

illuminating the information recording layer with the reference light for reproduction on the same side of the information recording layer that is illuminated with the information light and the modulated reference and collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction, wherein the reference light for reproduction and the reproduction light pass through the object lens such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on a same line; and

detecting the collected reproduction light.

55. (Previously Presented) The optical information recording and reproducing method according to claim 54, wherein the modulating is one or more of spatially modulating and phase modulating.

56. (Currently Amended) An optical information reproducing apparatus for reproducing information utilizing holography from an optical information recording medium having a reflecting layer film and an information recording layer in which the information is recorded in the form of an interference pattern between information light carrying the information and reference light, the apparatus comprising:

a reference light generator that spatially modulates the ~~phase of~~ light to generate reference light in the same manner in which the reference light was modulated during recording; and

a reproducing optical system including only one object lens, that illuminates, to a same side of the information recording layer that is illuminated with the information light and the reference light during recording, the information recording layer with the reference light through the object lens and collects, from a same side of the information recording layer that is illuminated with the reference light, reproduction light emanating from the information recording layer through the object lens;

wherein the reproducing optical system projects the reference light and collects the reproduction light such that an optical axis of the reference light and an optical axis of the reproduction light are located on a same line.

57. (Cancelled)

58. (Previously Presented) The optical information reproducing apparatus according to claim 56, further comprising a position controller that positions the reference light on the optical information recording medium based on position information in the optical information recording medium.

59. (Currently Amended) An optical information recording- and reproducing apparatus for recording information in an optical information recording medium having a reflecting layer film and an information recording layer in which information is recorded utilizing holography and for reproducing the information from the optical information recording medium, the apparatus comprising a pick-up device disposed on a side of the optical information recording medium, the pick-up device having:

a light source for emitting light;

an information light generator that spatially modulates a first portion of the light based on the information;

a reference light generator that generates a first reference light for recording and a second reference light for reproduction from a second portion of the light, wherein the modulation means spatially modulates the ~~phase of~~ second reference light for reproduction in the same manner in which the first reference light for recording was modulated when the information was recorded; and

an optical system including only one object lens, that illuminates the side of the information recording layer with the information light and the first reference light through the object lens to record the information in the information recording layer as an interference pattern between the information light and the first reference light, and that illuminates the information recording layer with the second reference light on the same side of the information recording layer that is illuminated with the information light and the first reference light through the object lens and collects reproduction light emanating from the side of the information recording layer when illuminated with the second reference light through the object lens.

60. (Previously Presented) The optical information recording and reproducing apparatus according to claim 59, wherein the first reference light is one or more of spatially

modulated and phase modulated to record the information and the second reference light is modulated in substantially a same way as a reference light used to record the information that is to be reproduced.

61.-78. (Cancelled)

79. (Currently Amended) An optical information recording and reproducing apparatus for recording information ~~on~~in and reproducing information from an optical information recording medium having a reflecting ~~layer film~~ and an information recording layer in which information is recorded utilizing holography in the form of an interference pattern as a result of interference between information light carrying the information and reference light for recording having a ~~spatially-modulated phases~~spatial modulation, the apparatus comprising:

an information light generation unit configured to generate plural information lights each of which carries corresponding two dimensional pattern information;

a recording reference light generation unit, including a ~~phase~~-modulator for spatially modulating a ~~phase of~~ light, configured to generate plural reference lights for recording each of which is spatially modulated by said ~~phase~~-modulator in response to a unique phase modulation pattern for said each two dimensional pattern information;

an optical recording unit, including only one object lens, configured to illuminate said information layer with said plural information lights and said plural reference lights for recording through the object lens so that an optical axis of each information light and an optical axis of the corresponding reference light for recording are located on the same line, to perform a multiplex recording to record on the same location of said optical information recording medium information in the form of plural interference patterns as a result of interferences between said plural information lights and said plural reference lights for recording;

a reproduction reference light generation unit, including ~~phase~~a modulator for spatially modulating the ~~phase of~~ light, configured to generate plural reference lights for reproduction each of which is spatially modulated by said ~~phase~~ modulator in response to a unique phase modulation pattern for said each two dimensional pattern information in the same manner in which the reference light was modulated when the information was recorded;

an optical reproducing unit, including the object lens, configured to illuminate the information recording layer with the reference light for reproduction generated by the reproduction reference light generation unit on the same side of the information recording layer that is illuminated with the corresponding information light and the corresponding reference light for recording through the object lens and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction through the object lens; and

a detection unit for detecting the reproduction light collected by the optical reproducing system.

80. (Previously Presented) The optical information recording and reproducing apparatus according to claim 79, wherein said optical recording unit performs said multiplex recording so that recording locations adjoining each other are overlapped in part in a certain direction on said optical information recording medium.

81. (Previously Presented) The optical information recording and reproducing apparatus according to claim 79, wherein said optical recording unit records a same interference pattern on plural locations of said optical information recording medium.

82. (Previously Presented) The optical information recording and reproducing apparatus according to claim 79, further comprising:

a two dimensional pattern information generation unit configured to generate said two dimensional pattern information by dividing information to be recorded into plural pieces of data,

wherein said optical recording unit performs said multiplex recording of said plural interference patterns spreading over plural locations on said optical information recording medium in a predetermined order.

83. (Previously Presented) The optical information recording and reproducing apparatus according to claim 82, further comprising:

a parity generation unit configured to generate parity data based on said two dimensional pattern information,

wherein said optical recording unit records on said optical information recording medium plural interference patterns corresponding to said parity data based on a predetermined rule.

84. (Previously Presented) The optical information recording and reproducing apparatus according to claim 83,

wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of said two dimensional pattern information, and

said optical recording unit records all interference patterns corresponding to said plural sets of parity data on one location on said optical information recording medium.

85. (Previously Presented) The optical information recording and reproducing apparatus according to claim 83,

wherein said parity generation unit generates plural sets of parity data corresponding to plural sets of said two dimensional pattern information, and

said optical recording unit records plural interference patterns corresponding to said plural sets of parity data spreading over plural locations, ~~on each~~ of which includes an interference pattern corresponding to at least one of said plural sets of parity data.

86.-95. (Cancelled)

96. (New) A holographic optical information recording apparatus, comprising:  
information light generation means for generating information light carrying information;

recording reference light generation means for generating non-parallel, spatially modulated reference light; and

a recording optical system that projects the information light and the reference light for recording along a common optical axis.

97. (New) The holographic optical information recording apparatus of claim 96, wherein the recording optical system projects the information light and the reference light for recording through only one object lens onto an optical information recording medium.

98. (New) The holographic optical information recording apparatus of claim 97, wherein the optical information recording medium comprises a reflecting layer.

99. (New) The holographic optical information recording apparatus of claim 96, further comprising a detector, the detector detecting information reproduced by a non-parallel, spatially modulated reference light for reproduction based on a recording medium that recorded the information using the recording optical system.



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**PATENT APPLICATION**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Hideyoshi HORIMAI

Group Art Unit: 2872

Application No.: 10/123,132

Examiner: A. Lavarias

Filed: April 17, 2002

Docket No.: 106357.01

For: APPARATUS AND METHOD FOR RECORDING AND REPRODUCING OPTICAL  
INFORMATION AND, APPARATUS AND METHOD FOR REPRODUCING  
OPTICAL INFORMATION (AS AMENDED)

**AMENDMENT UNDER 37 C.F.R. §1.111**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In reply to the June 14, 2004 Office Action, please consider the following:

**Amendments to the Claims** as reflected in the listing of claims; and

**Remarks.**

**Amendments to the Claims:**

The following listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) An optical information recording ~~and reproducing~~ apparatus for recording information in ~~and reproducing information from an~~ optical information recording medium having an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source ~~for emitting beams of light, wherein the light source is a semiconductor laser;~~

information light generation means for generating information light carrying information using the beams of light emitted by the light source;

recording reference light generation means including ~~a phase modulation~~ means for spatially modulating ~~the phase of the~~ beams of light emitted by the light source, for generating reference light for recording ~~having a being phase~~ spatially modulated by the ~~phase modulation~~ means; and

a recording optical system including only one object lens for projecting the information light generated by the information light generation means and the reference light for recording generated by the recording reference light generation means upon the optical information recording medium, for illuminating the information recording layer on the same side thereof with the information light ~~generated by the information light generation means~~ and the reference light for recording ~~generated by the recording reference light generation means~~ such that the information is recorded in the information recording layer in the form of

an interference pattern as a result of interference between the information light and the reference light for recording,

wherein the recording optical system projects the information light and the reference light for recording such that ~~the~~an optical axis of the information light and ~~the~~an optical axis of the reference light for recording are located on ~~the~~a same line, ~~and the optical length of the information light and the optical length of the reference light for recording are equal;~~

~~reproduction reference light generation means including phase modulation means for spatially modulating the phase of light in the same manner in which the reference light was modulated when the information was recorded, for generating reference light for reproduction having a phase spatially modulated by the phase modulation means;~~

~~———— a reproducing optical system for illuminating the information recording layer with the reference light for reproduction generated by the reproduction reference light generation means and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the same side of the information recording layer that is illuminated with the reference light for reproduction; and  
———— detection means for detecting the reproduction light collected by the reproducing optical system.~~

2. (Cancelled)

3. (Cancelled)

4. (Currently Amended) An optical information recording and reproducing apparatus for recording information in and reproducing information from an optical information recording medium having an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source ~~for emitting beams of light, wherein the light source is a semiconductor laser;~~

information light generation means for generating information light carrying information using the beams of light emitted by the light source~~spatially modulating the beams of light emitted by the light source to generate information light carrying information;~~

recording reference light generation means including modulation means for spatially modulating the beams of light emitted by the light source, for generating reference light for recording being spatially modulated by the modulation means~~using the beams of light emitted by the light source;~~ and

a recording optical system including only one object lens for projecting the information light generated by the information light generation means and the reference light for recording generated by the recording reference light generation means upon the optical information recording medium, for illuminating the information recording layer on the same side thereof with the information light ~~generated by the information light generation means~~ and the reference light for recording ~~generated by the recording reference light generation means~~ such that the information is recorded in the information recording layer in the form of an interference pattern as a result of interference between the information light and the reference light for recording, wherein the recording optical system projects the information light and the reference light for recording such that ~~the~~ a first optical axis of the information light and ~~the~~ a second optical axis of the reference light for recording are located on ~~the~~ a first same line, ~~and the optical length of the information light and the optical length of the reference light for recording are equal;~~

reproduction reference light generation means including ~~a phase-modulation~~ means for spatially modulating the beams phase of light in ~~the~~ a same manner in which the reference light was modulated when the information was recorded, for generating reference light for reproduction ~~having a phase-being~~ spatially modulated by the ~~phase-modulation~~ means;

a reproducing optical system including the object lens for projecting the reference light for reproduction generated by the reproduction reference light generation means upon the optical information recording medium and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction, for illuminating the information recording layer with the reference light for reproduction ~~generated by the reproduction reference light generation means~~ and for collecting the reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on the ~~a~~ same side of the information recording layer that is illuminated with the reference light for reproduction, wherein the reproducing optical system projects the reference light for reproduction and collects the reproduction light such that a third optical axis of the reference light for reproduction and a fourth optical axis of the reproduction light are located on a second same line; and

detection means for detecting the reproduction light collected by the reproducing optical system.

5. (Cancelled)

6. (Previously Presented) An optical information recording and reproducing apparatus according to claim 4, wherein the information light generation means spatially modulates the beams of light emitted by the light source to generate information light carrying information.

7. (Cancelled)

8. (Cancelled)

9. (Currently Amended) An optical information recording/reproducing apparatus for recording information in an optical information recording medium having an information recording layer in which information is recorded utilizing holography and for reproducing the information from the optical information recording medium, the apparatus comprising a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source ~~for emitting beams of light, wherein the light source is a semiconductor laser;~~

information light generation means for generating information light carrying information by spatially modulating the beams of light emitted by the light source;

recording reference light generation means for generating reference light for recording using the beams of light emitted by the light source;

reproduction reference light generation means for generating reference light for reproduction using the beams of light emitted by the light source;

a recording/reproducing optical system including only one object lens for projecting the reference light, for: illuminating through the object lens to the same side of the information recording layer with the information light generated by the information light generation means and the reference light for recording generated by the recording reference light generation means such that the information is recorded in the information recording layer in the form of an interference pattern as a result of interference between the information light and the reference light for recording; illuminating through the object lens to the information recording layer with the reference light for reproduction generated by the reproduction reference light generation ~~means in the same manner in which the reference light was modulated when the information was recorded;~~ and collecting through the object lens

reproduction light generated at the information recording layer when illuminated with the reference light for reproduction on ~~the~~ a same side of the information recording layer that is illuminated with the reference light for reproduction; and

detection means for detecting the reproduction light collected by the recording/reproducing optical system,

wherein the ~~recording~~ recording/reproducing optical system projects the information light and the reference light for recording such that ~~the~~ a first optical axis of the information light and ~~the~~ a second optical axis of the reference light for recording are located on ~~the~~ a first same line, and the recording/reproducing optical system projects the reference light for reproduction and collects the reproduction light such that ~~the~~ a third optical axis of the reference light for reproduction and ~~the~~ a fourth optical axis of the reproduction light are located on ~~the~~ a second same line, ~~and the optical length of the information light and the optical length of the reference light for recording are equal.~~

10. (New) An optical information recording apparatus according to claim 1, wherein the modulation means of the recording reference light generation means modulates the phase of the beams of light.

11. (New) An optical information recording and reproducing apparatus according to claim 4, wherein the modulation means of the recording reference light generation means modulates the phase of the beams of light and the modulation means of the reproducing reference light generation means modulates the phase of the beams of light.

12. (New) An optical information reproducing apparatus for reproducing information from an optical information recording medium having an information recording layer in which information is recorded utilizing holography, the apparatus comprising:

a pick-up device provided in a face-to-face relationship with the optical information recording medium, the pick-up device having:

a light source;

a reproduction reference light generation means including modulation means for spatially modulating the beams of light emitted by the light source in the same manner in which the reference light was modulated when the information was recorded, for generating reference light for reproduction being spatially modulated by the modulation means;

a reproducing optical system including only one object lens for projecting the reference light for reproduction generated by the reproduction reference light generation means upon the optical information recording medium and for collecting reproduction light generated at the information recording layer when illuminated with the reference light for reproduction, for illuminating the information recording layer with the reference light for reproduction and for collecting the reproduction light on a same side of the information recording layer that is illuminated with the reference light for reproduction;

detection means for detecting the reproduction light collected by the reproducing optical system; and

wherein the reproducing optical system projects the reference light for reproduction and collects the reproduction light such that an optical axis of the reference light for reproduction and an optical axis of the reproduction light are located on a same line.

13. (New) An optical information reproducing apparatus according to claim 12, wherein the modulation means of the reproducing reference light generation means modulates the phase of the beams of light.